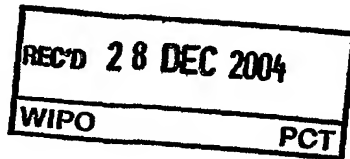| Europäisches Patentamt | European Patent Office | Office européen des brevets |

Bescheinigung   Certificate   Attestation

Die angehefteten Unterlagen stimmen mit der ursprünglich eingereichten Fassung der auf dem nächsten Blatt bezeichneten europäischen Patentanmeldung überein.

The attached documents are exact copies of the European patent application described on the following page, as originally filed.

Les documents fixés à cette attestation sont conformes à la version initialement déposée de la demande de brevet européen spécifiée à la page suivante.

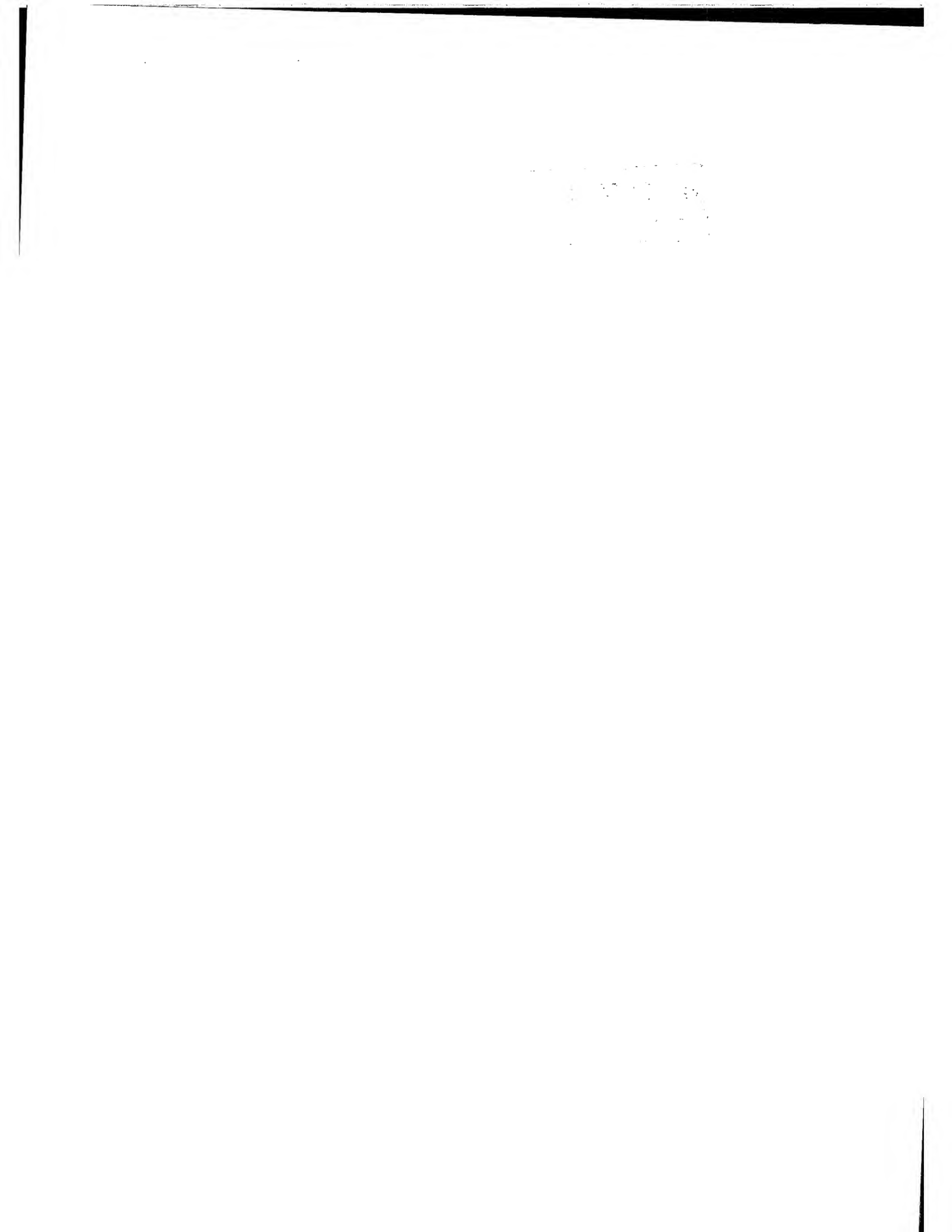| Patentanmeldung Nr. | Patent application No. | Demande de brevet n° |

03300284.1

PRIORITY DOCUMENT
SUBMITTED OR TRANSMITTED IN COMPLIANCE WITH RULE 17.1(a) OR (b)

Der Präsident des Europäischen Patentamts;
Im Auftrag

For the President of the European Patent Office

Le Président de l'Office européen des brevets
p.o.

R C van Dijk

Anmeldung Nr:
Application no.:   03300284.1

Demande no:

Anmeldetag:
Date of filing: 23.12.03

Date de dépôt:

Anmelder/Applicant(s)/Demandeur(s):

Koninklijke Philips Electronics N.V.
Groenewoudseweg 1
5621 BA Eindhoven
PAYS-BAS

Bezeichnung der Erfindung/Title of the invention/Titre de l'invention:
(Falls die Bezeichnung der Erfindung nicht angegeben ist, siehe Beschreibung.
If no title is shown please refer to the description.
Si aucun titre n'est indiqué se referer à la description.)

Method and system for stabilizing a video sequence

In Anspruch genommene Prioriät(en) / Priority(ies) claimed /Priorité(s)
revendiquée(s)
Staat/Tag/Aktenzeichen/State/Date/File no./Pays/Date/Numéro de dépôt:

Internationale Patentklassifikation/International Patent Classification/
Classification internationale des brevets:

H04N7/00

Am Anmeldetag benannte Vertragstaaten/Contracting states designated at date of
filing/Etats contractants désignées lors du dépôt:

AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IT LU MC NL
PT RO SE SI SK TR LI

1

Method and system for stabilizing a video sequence

FIELD OF THE INVENTION

The present invention relates to a method for stabilizing a video recording of a scene made by a video camera, and to a stabilizing system for carrying out said method.

BACKGROUND OF THE INVENTION

5   Miniaturization of video cameras in the recent years and inclusion of powerful zooms have led in these devices to an image stability problem, owing to the movement of the handheld video camera. Digital image stabilizing (DIS) systems have then been developed in order to remove this unwanted camera movement − or jitter − and thus to produce a sequence

10   displaying requisite camera movement only and providing a more pleasant viewing experience. Jitter, defined as all the undesired positional fluctuations (translation, rotation, etc...) of the image that are added to the intentional motion of the camera, can have a lot of significant adverse effects (for example, on motion estimation coding, since it may increase the magnitude or the number of the motion vectors and therefore a decrease in the run length

15   of encoded motion vectors). In most DIS systems, a motion estimation is performed between two successive frames (at times t-1 and t) in order to get the global motion of the image frame. Said global motion is represented by a single vector called the global motion vector GMV(t). The problem is that the successive values GMV(t) contain both the intentional motion and the unintentional one (jitter).

20   The document "Fast digital image stabilizer based on Gray-coded bit-plane matching", IEEE Transactions on Consumer Electronics, vol.45, n°3, August 1999, pp.598-603, describes a motion correction system allowing to decide whether the motion is intentional or not. To that end, the global motion vector is integrated with a damping coefficient, and the integrated motion vector IMV(t) thus defined designates the final motion

25   vector correction to be applied to the current raw frame for motion correction. This integrated motion vector, provided for constructing a stabilized sequence, is given by the expression (1) :

$$IMV(t) = a \cdot IMV(t-1) + GMV(t) \qquad (1)$$

where GMV(t) is the global motion vector for the current frame considered at the time t and a is a damping factor (0 < a < 1) playing a role according to which the integrated motion vector converges to zero when there is no camera motion. The choice of this damping factor depends on the degree of stabilization desired, but it is crucial considering the type of camera

5   motion, and the use of a constant value (for example) is often sub-optimal.

In fact, separating the intentional motion from jitter over the course of a sequence is always a complex problem. For a real-time application, the main constraint is moreover that no delay is allowed, i.e. it is not possible to store some frames in memory and to apply the motion correction later, once the movement can be better known. All the

10   solutions proposed to that end in the literature have more or less the same drawback : the jitter is attenuated – but not cancelled – in portions of sequences that have a low amplitude jitter and fixed position, but as soon as there is a panoramic motion or any other type of strong camera motion, the output filtered sequence hardly follows the real motion or follows it after a long delay. Moreover, the sampling window used for filtering causes a delay that is

15   noticeable when correcting low amplitude jitter. There is consequently always to find a trade-off between the strength for attenuating low amplitude jitter and the ability to follow intentional motion with a delay as low as possible.

SUMMARY OF THE INVENTION

It is therefore an object of the invention to propose a filtering method allowing

20   to perform an improved motion correction.

To that end, the invention relates to a method for stabilizing a video recording of a scene made by a video camera and represented by video data, said method comprising the steps of :

- subdividing said video data into a plurality of successive frames ;

- dividing each of said successive frames into a plurality of blocks ;

- determining for each block of each frame a motion vector representing the direction and magnitude of the motion in said block, said vector GMV at an instant t being called global motion vector GMV(t) and representing said motion at the instant t with respect

25   to the previous frame ;

- defining a modified vector, called integrated motion vector IMV(t) at the instant t and designating the final motion vector correction to be applied to the current frame in view of its motion correction, said integrated motion vector being given by the expression :

$$IMV(t) = GMV(t) + a(.) \cdot IMV(t-1)$$

where GMV(t) is the global motion vector of the current frame at the instant t, a(.) is a variable adaptive factor and IMV(t − 1) is the integrated motion vector corresponding to the previous current frame ; and

        - modifying the video data according to the modified integrated motion vectors

5   defined for each successive current frame.

        Preferably, this variable damping factor is calculated independently for the horizontal and vertical coordinates of the IMVs and GMVs, and thus the filtering along the two axes is always independent from each other.

        It may also be checked if the IMV correction is not above a given threhsold,

10   corresponding to the extra input area authorized : if so, the correction is modified in order to stay within a predetermined allowed range, +/− 16 pixels for example.

DETAILED DESCRIPTION OF THE INVENTION

        In accordance with the present invention, a stabilization method is proposed in which the proposed correction is now equal to the integrated motion vector IMV(t)

15   previously defined, but with a damping coefficient which is now adaptive :

$$IMV(t) = a(t, t\text{-}1, \ldots) \cdot IMV(t − 1) + GMV(t) \qquad (2)$$

In this expression (2), the damping factor a(.) is now no longer a constant value, but an adaptive one depending for instance on the sum of the two last global motion vectors. This allows to track the beginning of intentional motion (the last global motion vector being

20   usually too instable to be used per se).

        The correspondence table between the damping factor a(.) and the sum (GMV(t) + GMV(t-1)) of the two last global motion vectores is built in the following way :

        (a) a low sum of GMV values implies a high damping factor value, which strongly stabilizes the sequence, as if assuming static intentional camera ;

25   (b) a high sum of GMV values implies a low damping factor value, and the sequence then follows more precisely the original motion.

        Some additional features may be proposed. It is for example advantageous if one has a filtering on the x-vector independent of y-vector filtering. Moreover, an out of bounds detection may be provided : said detection allows to check if the IMV correction is

30   not above a given threshold, corresponding to an extra input area authorized, and to correct it to stay within an allowed range, for instance +/- 16 picture elements (pixels).

        The proposed stabilizing method thus creates long stabilized shots when jitter is centered around a certain spatial position, while following intentional motion when the

motion is too high. Some fast moving transitions may be still visible, but they generally correspond to abrupt motion in the original sequence that must be followed in some way, if one wants to stay within the allowed extra image bounds. The stabilizing method is also effective in tracking slow moving motion.

CLAIMS:

1.   A method for stabilizing a video recording of a scene made by a video camera and represented by video data, said method comprising the steps of :

- subdividing said video into a plurality of successive frames ;

- dividing each of said successive frames into a plurality of blocks ;

- determining for each block of each frame a motion vector representing the direction and magnitude of the motion in said block, said vector GMV at an instant t being called global motion vector GMV(t) and representing said motion at the instant t with respect

5   to the previous frame ;

- defining a modified vector, called integrated motion vector IMV(t) at the instant t and designating the final motion vector correction to be applied to the current frame in view of its motion correction, said integrated motion vector being given by the expression :

$$IMV(t) = GMV(t) + a(.) . IMV(t-1)$$

10   where GMV(t) is the global motion vector of the current frame at the instant t, a(.) is a variable adaptive factor and IMV(t − 1) is the integrated motion vector corresponding to the previous current frame ; and

- modifying the video data according to the modified integrated motion vectors ` defined for each successive current frame.

15   2.   A stabilizing method according to claim 1, in which the variable damping factor a(.) is determined independently for the horizontal and vertical coordinates of the vectors.

3.   A stabilizing method according to anyone of claims 1 and 2, comprising an additional correction step, provided for checking if the correction of motion vector is not

20   above a given threshold and, if yes, modifying said correction so that it stays within a predetermined allowed range.

4.   A system for stabilizing a video recording of a scene made by a video camera and represented by video data, said system comprising :

- a frame storage for storing a plurality of successive frames of video data of

25   the video recording ;

- a processor coupled to said frame storage for dividing each frame into a plurality of blocks, determining for each block of each frame a motion vector which represents the direction and magnitude of the motion in said block, said vector at an instant t being called global motion vector GMV(t) and representing said motion at the instant t with

5   respect to the previous frame, defining a motion vector, called integrated motion vector IMV(t) at the instant t and designating the final motion vector correction to be applied to the current frame in view of its motion correction, said integrated motion vector being given by the expression :

$$IMV(t) = GMV(t) + a(.) \cdot IMV(t-1)$$

10   where GMV(t) is the global motion vector of the current frame at the instant t, a(.) is a variable adaptive factor and IMV(t − 1) is the integrated motion vector corresponding to the previous current frame, and modifying the video data according to the modified integrated motion vectors defined for each successive current frame.

7

Abstract

The invention relates to a method for stabilizing a video recording of a scene made by a video camera and represented by video data, said method comprising the steps of subdividing said video data into a plurality of successive frames themselves divided into a plurality of blocks, determining for each block of each frame a motion vector representing the direction and magnitude of the motion in said block, said vector at an instant t being called global motion vector GMV(t) and representing said motion at the instant t with respect to the previous frame, defining a modified vector called integrated motion vector IMV(t) at the instant t and designating the final motion vector correction to be applied to the current frame in view of its motion correction, said integrated motion vector being given by the expression :

$$IMV(t) = GMV(t) + a(.) \cdot IMV(t-1)$$

where a(.) is a variable adaptive factor and IMV(t − 1) is the integrated motion vector corresponding to the previous current frame, and modifying the video data according to the modified integrated motion vectors defined for each successive current frame.

5

PCT/IB2004/004227